Renewable Energy Technologies for Federal Facilities

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Solar Water Heating

Using the Sun to Heat Domestic Water Makes Sense in Almost Any Climate

More than one million homeowners and 200,000 businesses across the United States have discovered that the sun can heat domestic water efficiently in almost any climate. A solar water-heating system's performance depends primarily on outdoor temperature and the amount of sunlight striking the collector—the device that actually captures the sun's energy. In summer months, in most parts of the country, a solar system for a residential building can meet 100% of the water-heating requirements. In winter months, the system may meet only half the water-heating requirements; therefore, a backup heat source supplements the solar system.

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An active solar heating system supplies hot water to the visitors center at Mt. Rushmore.

Active solar water heaters use pumps to circulate water or some other fluid from the collectors, where it is heated by the sun, to the storage tank, where the water remains until needed. Active systems fall into two general groups based on freeze protection: those using a fluid with a low freezing point (such as propylene glycol) in the collector loop and those using water in the loop (which is automatically drained when the sun is not shining).

Passive solar water heaters, which rely on gravity, are typically either integral collector/storage (ICS) systems or thermosyphon systems (see box on back). The major advantage of these systems is that they don't use controls, pumps, sensors, or other mechanical parts, so minimal maintenance is required during their lifetime. They are less expensive than active solar systems and can only be used in warm sun-belt climates. The roof structure must be able to support the load of the storage tanks.

One of three types of solar collectors can be selected: flat-plate, evacuated-tube, and parabolic collectors. A *flat-plate collector* is basically a panel-shaped box containing fluid-filled tubes mounted on a dark-colored absorber. It is suitable for residential or nonresidential use and can also operate well in a humid climate, where haze creates more diffuse, rather than direct, sunlight.

In an *evacuated-tube collector*, side-by-side tubes hold the fluid to be heated. Each tube is surrounded by an outer glass tube, and a vacuum between the inner and outer tubes provides good insulation to reduce heat loss. The collector operates at high temperatures with high efficiency using direct and diffuse light.

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What are the important terms?

Drainback System—whenever the pump stops, water in the collector loop drains into a reservoir tank.

Draindown System—whenever freezing conditions occur, water flows from the collector loop and piping into a drain. Historically less reliable than a drainback system.

Integral Collector/Storage (ICS) System—also called a "batch" or "breadbox" water heater, this system combines the collector and storage tank into one unit. The sun shining into the collector strikes the storage tank directly, heating the water. The water's large thermal mass, plus insulation to reduce heat loss through the tank, prevents the stored water from freezing. Appropriate in mild climates.

Recirculation System—whenever freezing conditions occur, warm water from storage is circulated through the collectors and exposed piping. Best in mild climates.

Thermosyphon System—uses a separate storage tank located above the collector. Less-dense warm liquid in the collector rises naturally above the collector where it remains until needed. As the water cools in the tank and becomes more dense, it naturally sinks back down to the collector.

A *parabolic-trough collector* consists of a long U-shaped mirror that focuses the sun onto a fluid-filled tube along the center of the U-trough. This highly efficient system typically tracks the sun and requires direct, not diffuse, sunlight. The major use has been nonresidential or institutional applications such as prisons and hospitals.

What are the opportunities?

- Solar water heating is feasible in all building types, with common applications in

Residential buildings—for example, domestic uses such as showers, kitchens, and laundry

Commercial buildings—for example, cafeterias, day care centers, and recreational facilities with showers

Institutional buildings—for example, prisons and hospitals.

- Solar water heating works in all climates, although ICS and thermosyphon systems are best in warmer climates.
- Some utilities are encouraging solar water heating as a demand-side management strategy.

What is required?

- The water heating load should be relatively constant throughout the week.
- The solar system will generally be more cost effective if it displaces electrically heated water.
- There is a location on the roof or ground suitable for collectors. The roof should be unshaded and either flat or tilted south. The collector area required is about 1 to 1.5 ft^2 for each gallon of water use per day.
- The building manager is enthusiastic about using solar water heating, and personnel are interested in being trained to maintain the system.

What does it cost?

Solar water heaters can provide 40%–80% of the annual water-heating needs for various types of buildings. Installed costs are $40–$65 per ft^2 of collector area for systems using flat-plate collectors. System economics are most favorable when compared with electric water heating; however, it will vary, depending on geographic locale, water usage, and utility rates. New-construction systems usually have better economics than retrofit projects because of reduced installation expenses.

The Solar Rating and Certification Corporation (SRCC) tests performance and certifies almost every solar water heater on the market today. The SRCC—an independent, nonprofit organization directed by state government, solar industry representatives, and consumer groups—determines system performance in accordance with national ratings standards. SRCC certification allows consumers to choose among systems more intelligently and to be confident that systems will perform as claimed by vendors.

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For More Information

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